N90-22657

Program 5 **The Effects of Zinc Addition on the Environmental Stability of Al-Li Alloys**

Raymond J. Kilmer and G.E. Stoner

Objectives

The objectives for this study are:

1) to document and correlate the microstructure of the ALCOA provided 8090 + Zn alloy with corrosion behavior and SCC phenomena;

2) to identify the intermetallics present in 8090 + Zn alloy most notably in the aging regimes displaying optimal mechanical properties;

3) to compare and contrast with baseline 8090 with regard to corrosion and SCC behavior in a number of environments.

The Role of Zn Additions to the Environmental Stability of Alloy 8090

R.J. Kilmer and G.E. Stoner

Department of Materials Science

It has been found that relatively small additions of Zn can improve the stress corrosion cracking (SCC) resistance of Al-Li alloys. However, the mechanism by which this is accomplished is unclear. This present project will investigate the role that Zn plays in altering the behavior of Alloy 8090. Early results suggest that Zn additions increase the volume fraction of δ' (Al_3Li) precipitation and differential scanning calorimetry (DSC) on these alloys confirms this. The four alloys studied each had initial compositions lying in the 8090 window and had varying amounts of Zn added to them.

Alloy 8090, like other Al-Li alloys, displays a δ' precipitate free zone (PFZ) upon artificial aging along the grain and subgrain boundaries. However Zn additions greatly decreased or eliminated a δ' PFZ after 100 hours at 160°C. This implies that the subgrain boundary precipitation kinetics are being altered and suppressed. Furthermore there appears to be a window of Zn concentration above which a δ' PFZ can reappear with the nucleation and growth of a currently unidentified precipitate on the boundaries.

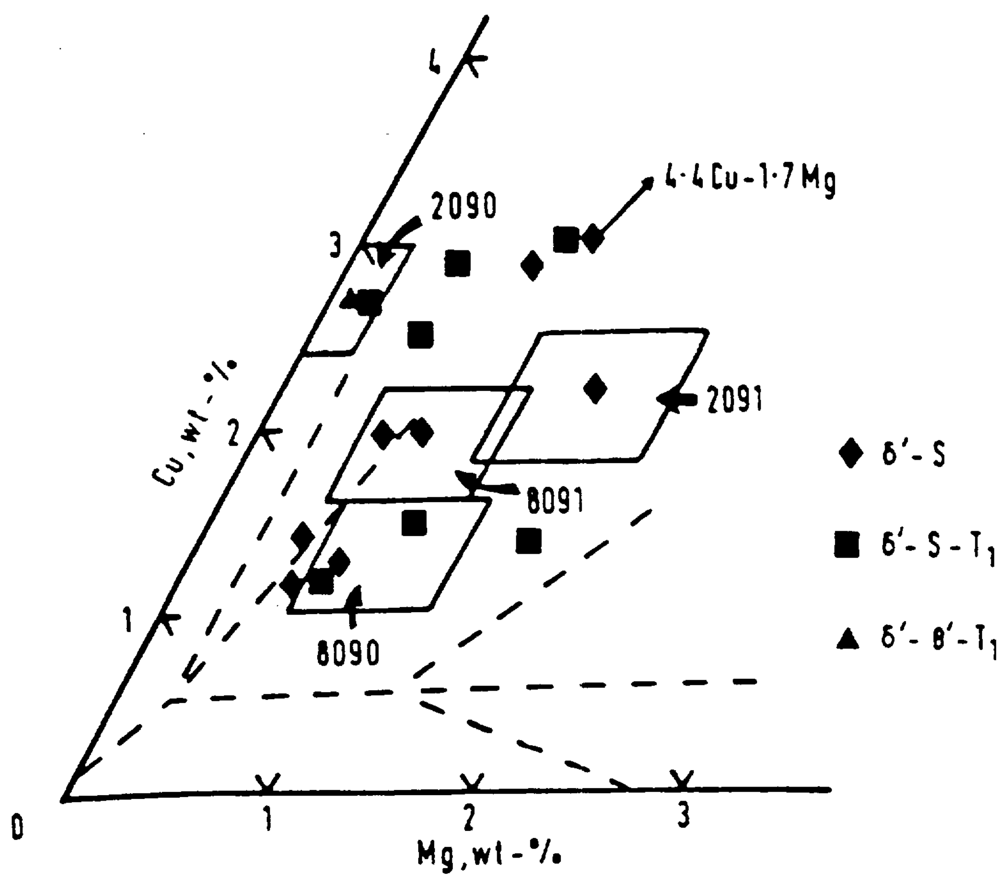
Polarization experiments were performed and the results presented. The experiments were performed in deaerated 3.5 w/o NaCl in both the as received (T3) condition and at peak aging of 100 hours at 160°C. The aging profile was determined via Vickers Hardness tests.

A proposed outline of the project will be presented with future research a main focus.

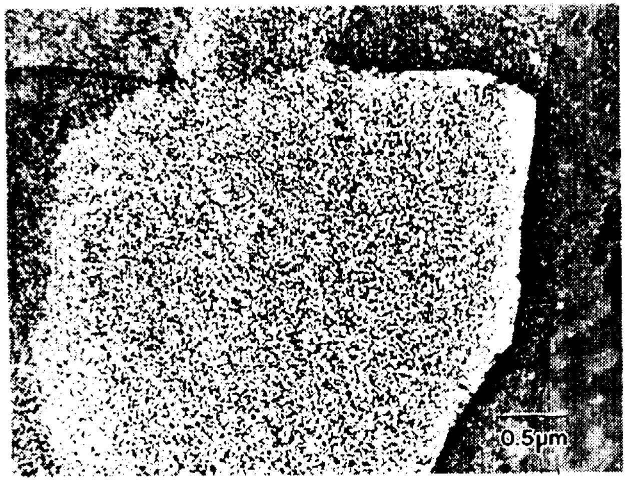
Sponsored by NASA, Langley Research Center, Hampton Virginia
Alcoa, Alcoa Technical Center, Alcoa Center, Pennsylvania

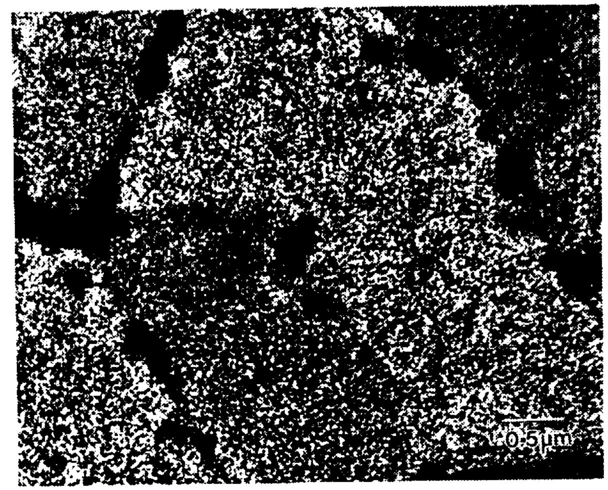
8090

Al-2.4Li-1.16Cu-0.67Mg-0.12Zr



Precipitate phases reported in quarternary Al–Cu–Mg alloys containing 2–3 wt-%Li in material aged at 190°C; where original source quotes composition range, centre of that range has been used as composition shown here; composition ranges of internationally designated Al–Li–Cu–Mg alloys and precipitate phase fields of ternary Al–Cu–Mg system at 190°C are also shown





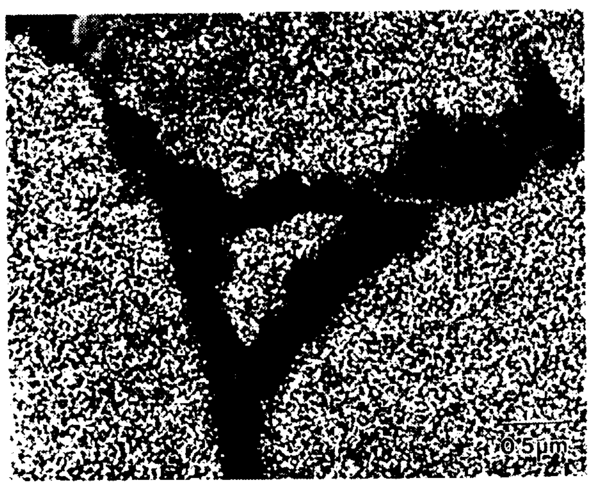
8 hrs

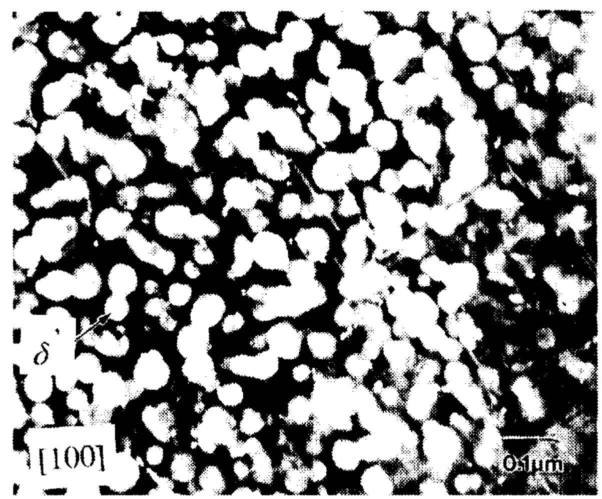
8090 Plate

15 hrs

Aging Temperature

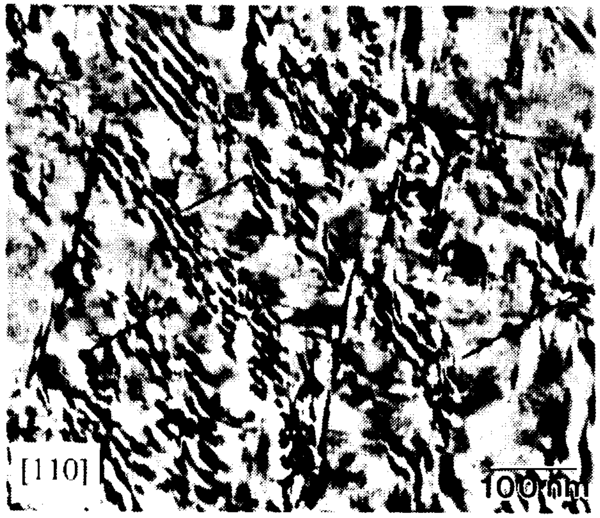
192 C

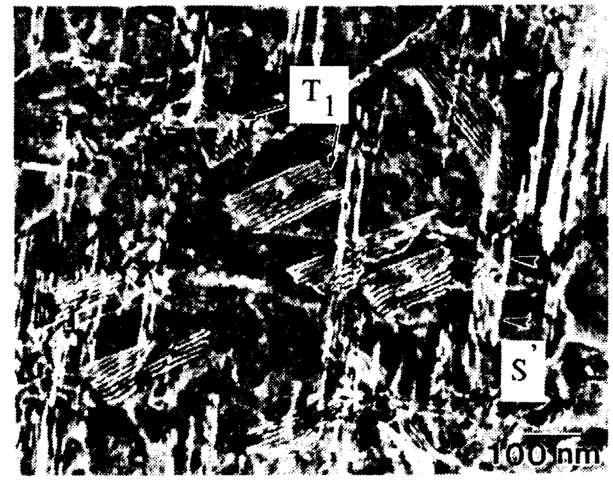




30 hrs

71 hrs





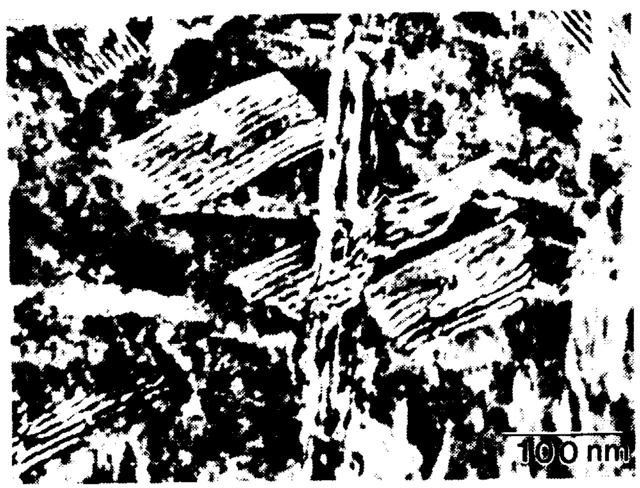
8090 Plate

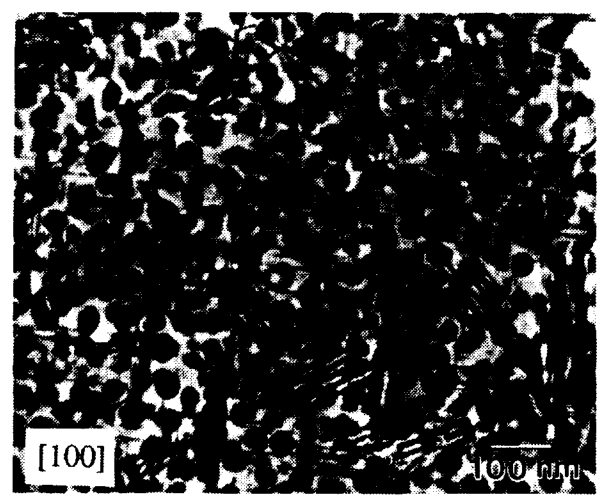
30 hrs

30 hrs

Aging Temperature

192 C

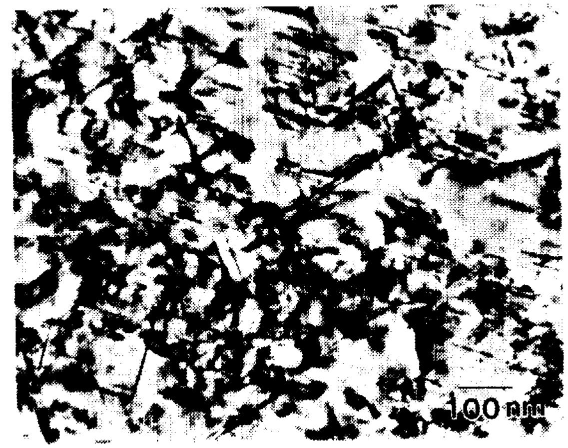




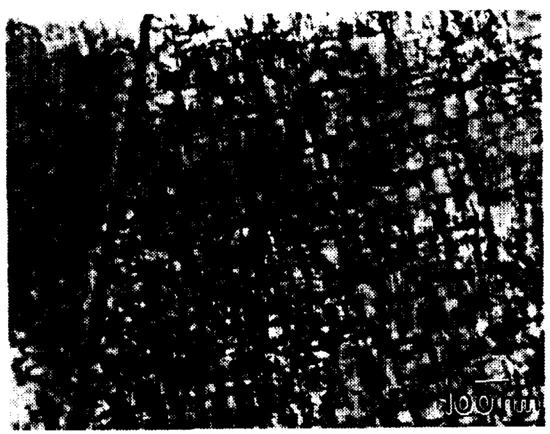
30 hrs

71 hrs

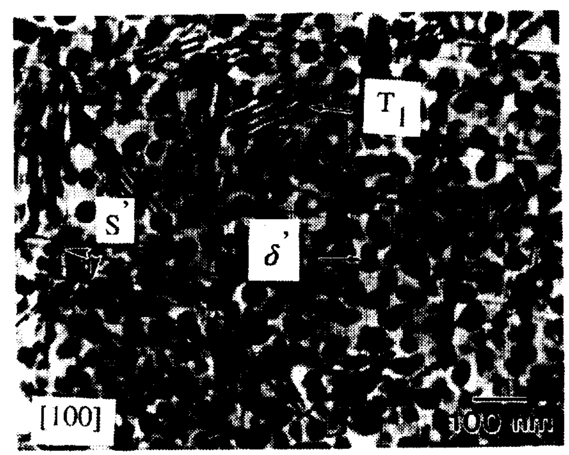
8 hrs



15 hrs



30 hrs

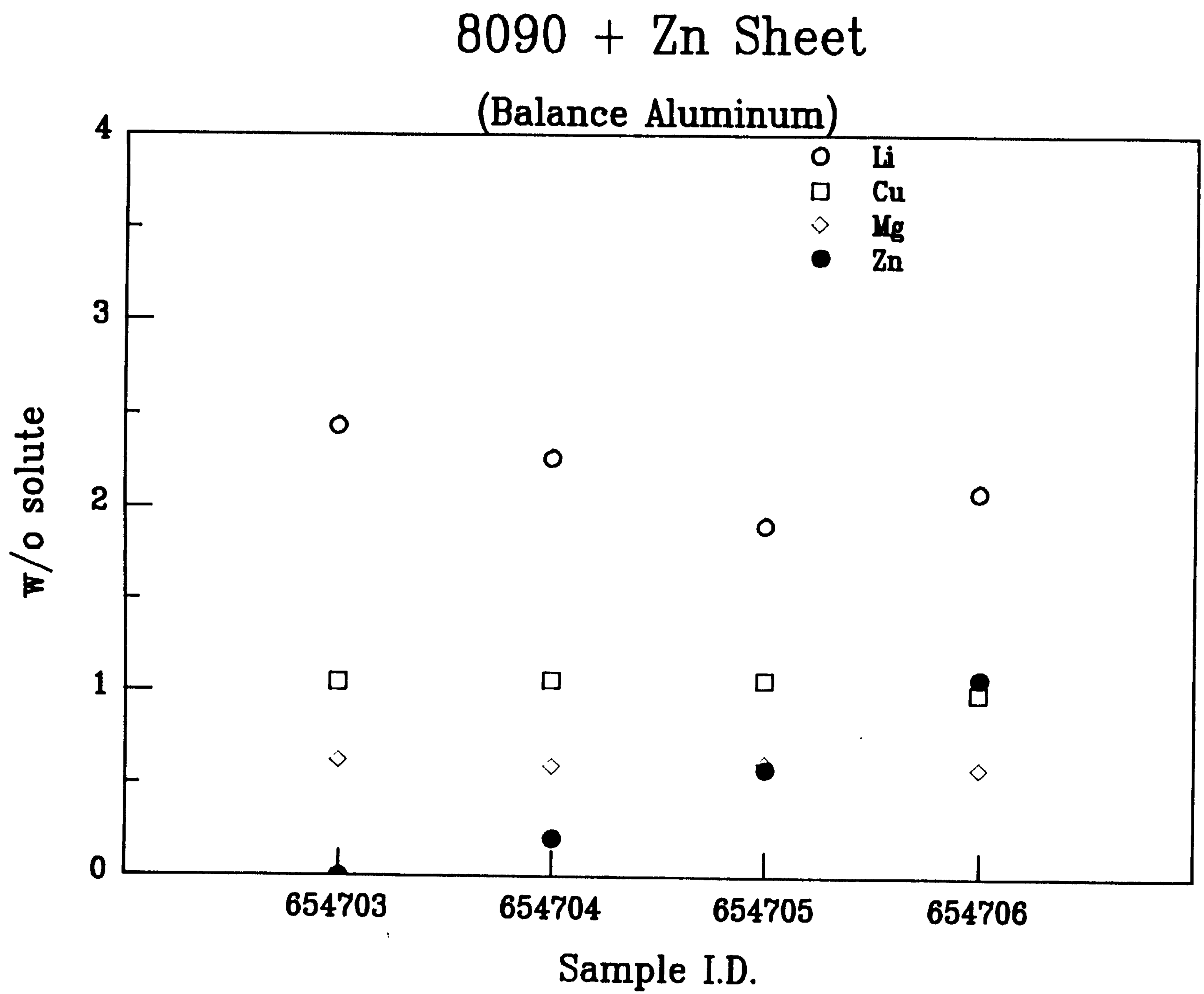


71 hrs

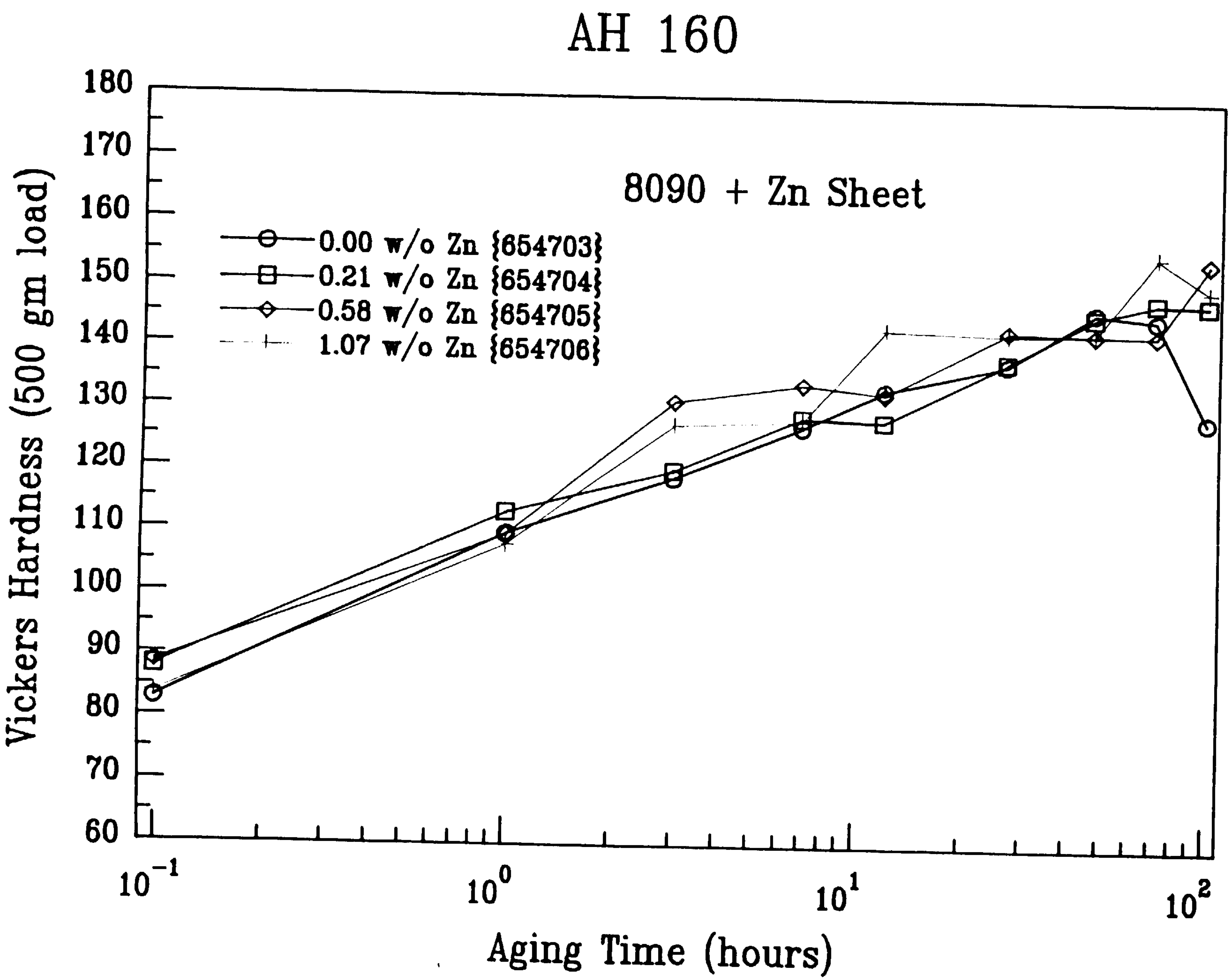
8090 + Zn Variants - Sheet

Atomic percent ratios

Sample I.D.	Target Alloy	Li/Zn	Cu/Zn	Mg/Zn
654703	8090 Baseline	-	-	-
654704	8090 + 0.21w/o Zn	101.8	5.2	7.7
654705	8090 + 0.58w/o Zn	31.0	1.9	2.9
654706	8090 + 1.07w/o Zn	18.4	1.0	1.5



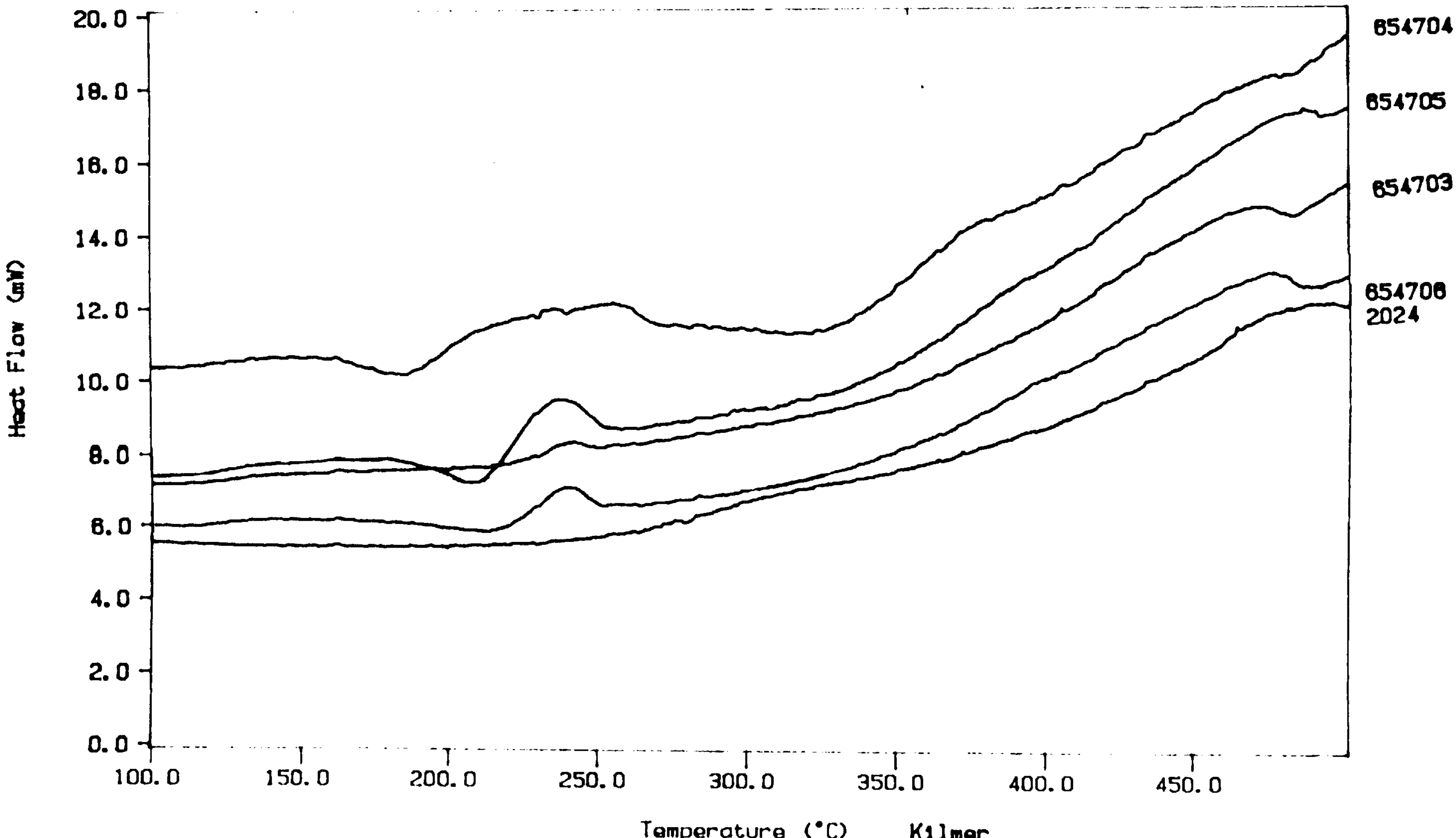
8090 + Zn Sheet
(Balance Aluminum)
Li
Cu
Mg
Zn
w/o solute
0
1
2
3
4
654703
654704
654705
654706
Sample I.D.



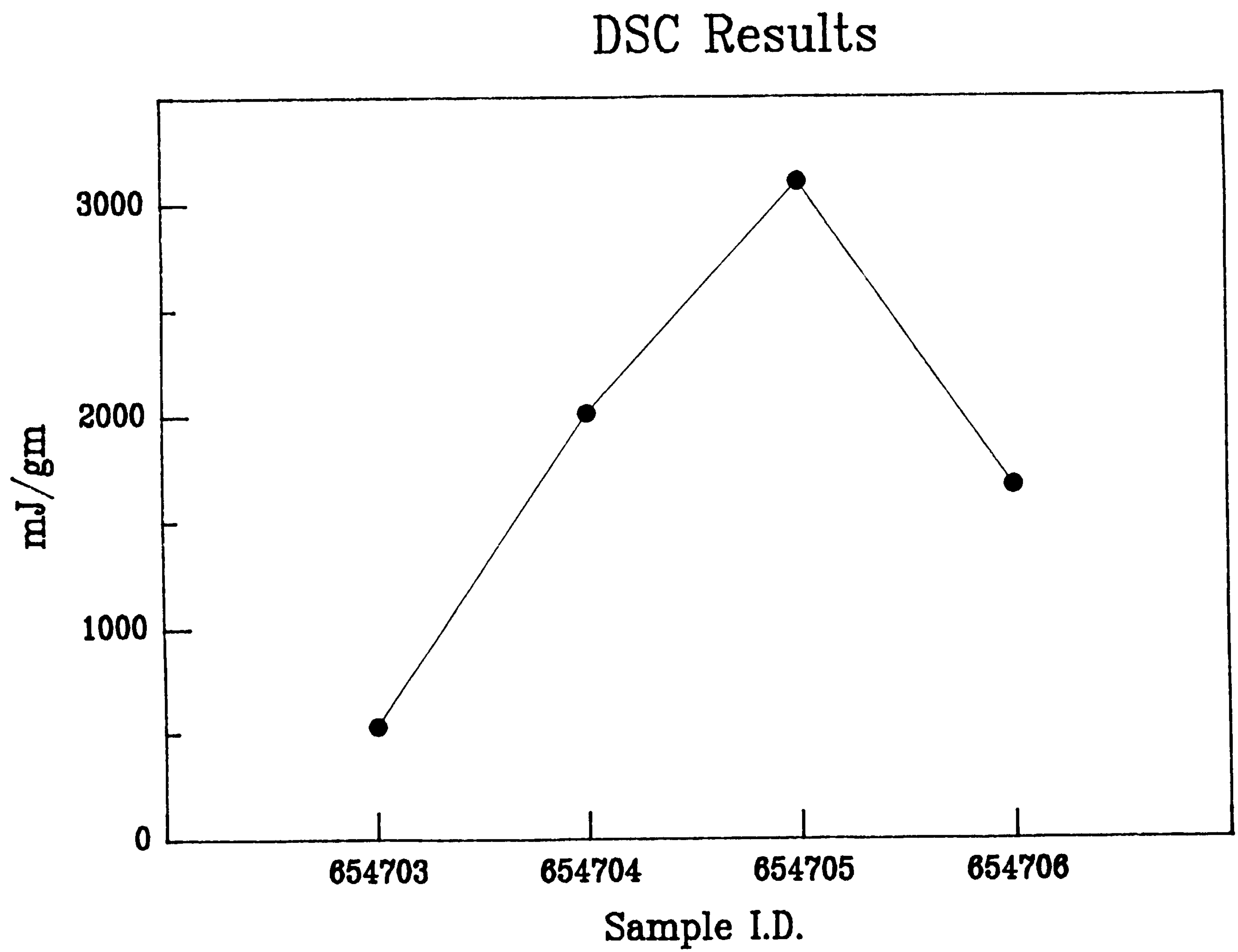
AH 160
8090 + Zn Sheet
0.00 w/o Zn {654703}
0.21 w/o Zn {654704}
0.58 w/o Zn {654705}
1.07 w/o Zn {654706}
Vickers Hardness (500 gm load)
180
170
160
150
140
130
120
110
100
90
80
70
60
10^{-1}
10^{0}
10^{1}
10^{2}
Aging Time (hours)

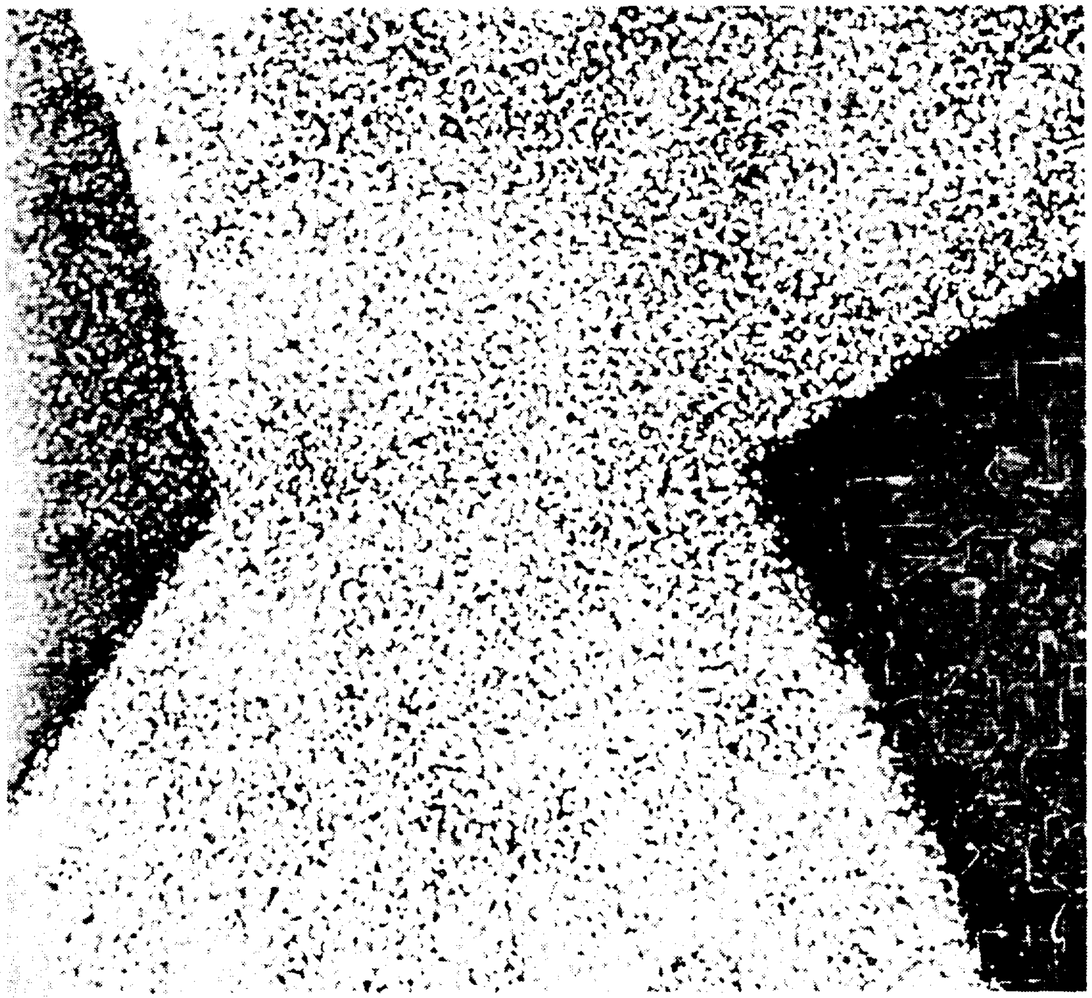
PERKIN-ELMER

7 Series Thermal Analysis System

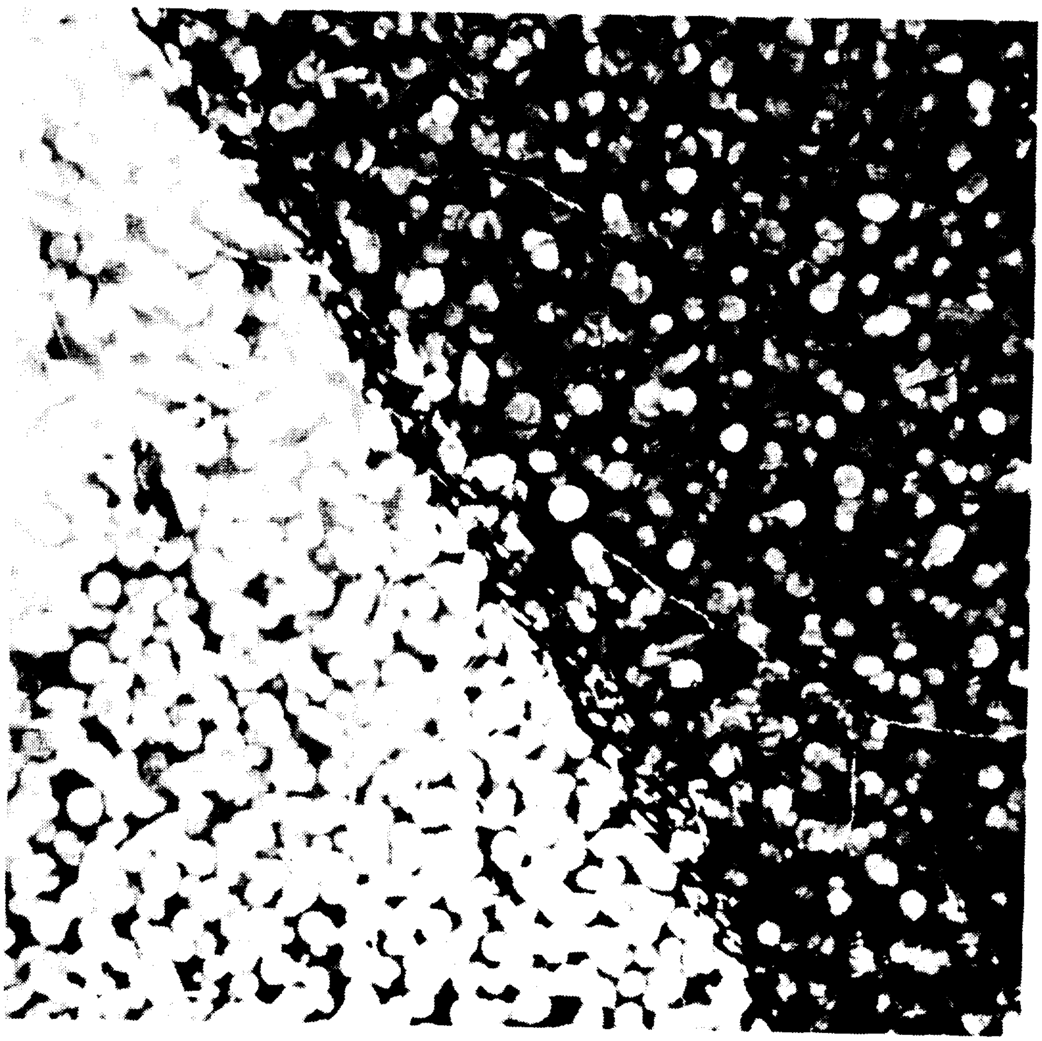


TEMP 1: 25.0 C TIME 1: 0.0 min RATE 1: 10.0 C/min
TEMP 2: 500.0 C

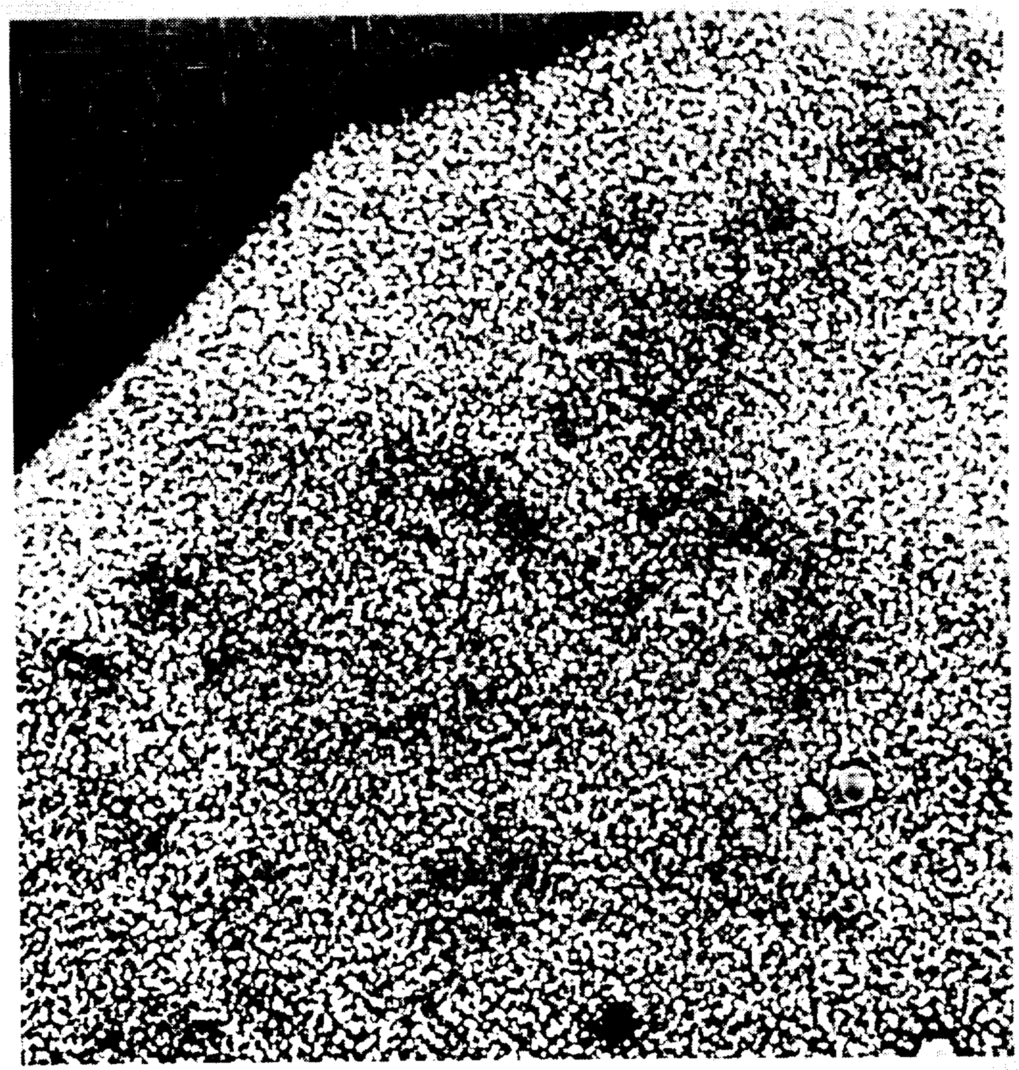

DSC Results
3000
2000
1000
0
mJ/gm
654703
654704
654705
654706
Sample I.D.



8090 + 0.2 w/o Zn (654704)

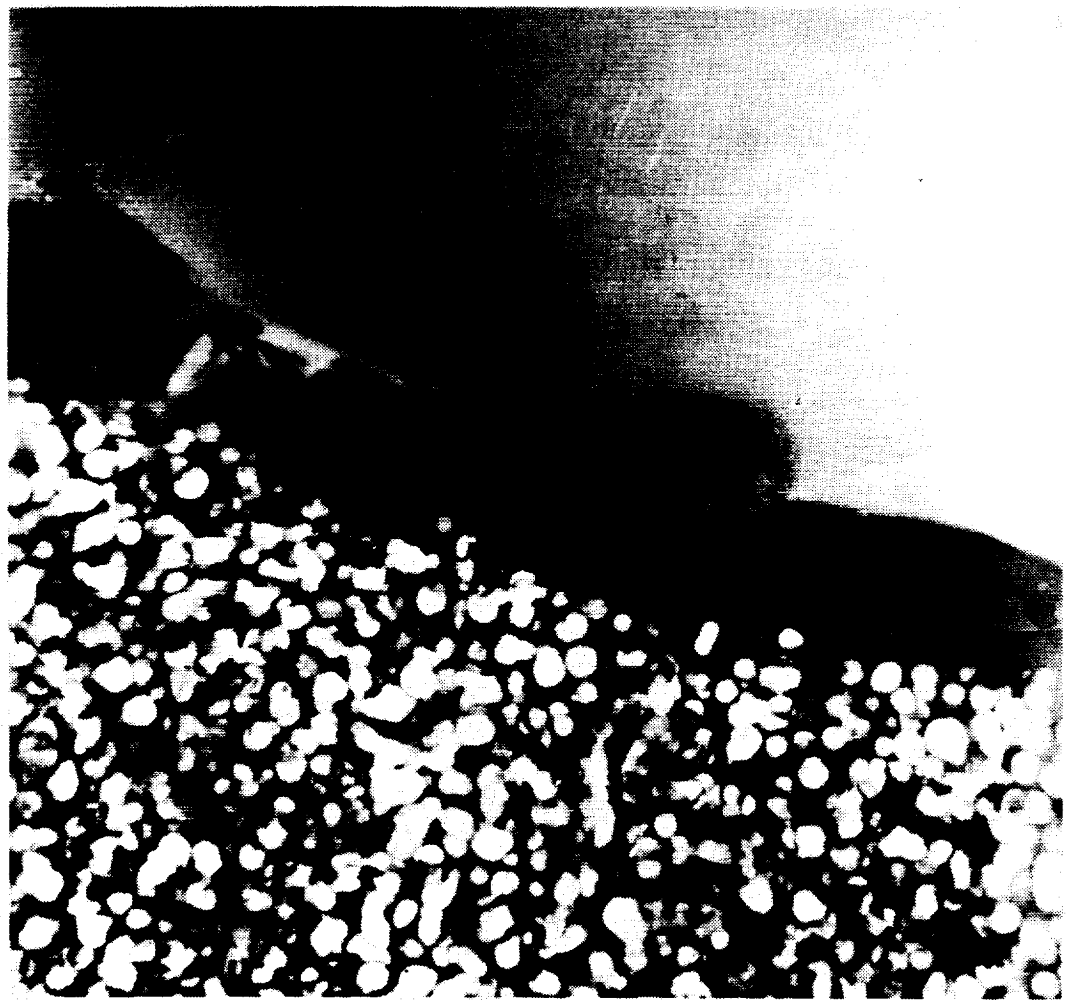


8090 + 0.2 w/o Zn (654704)



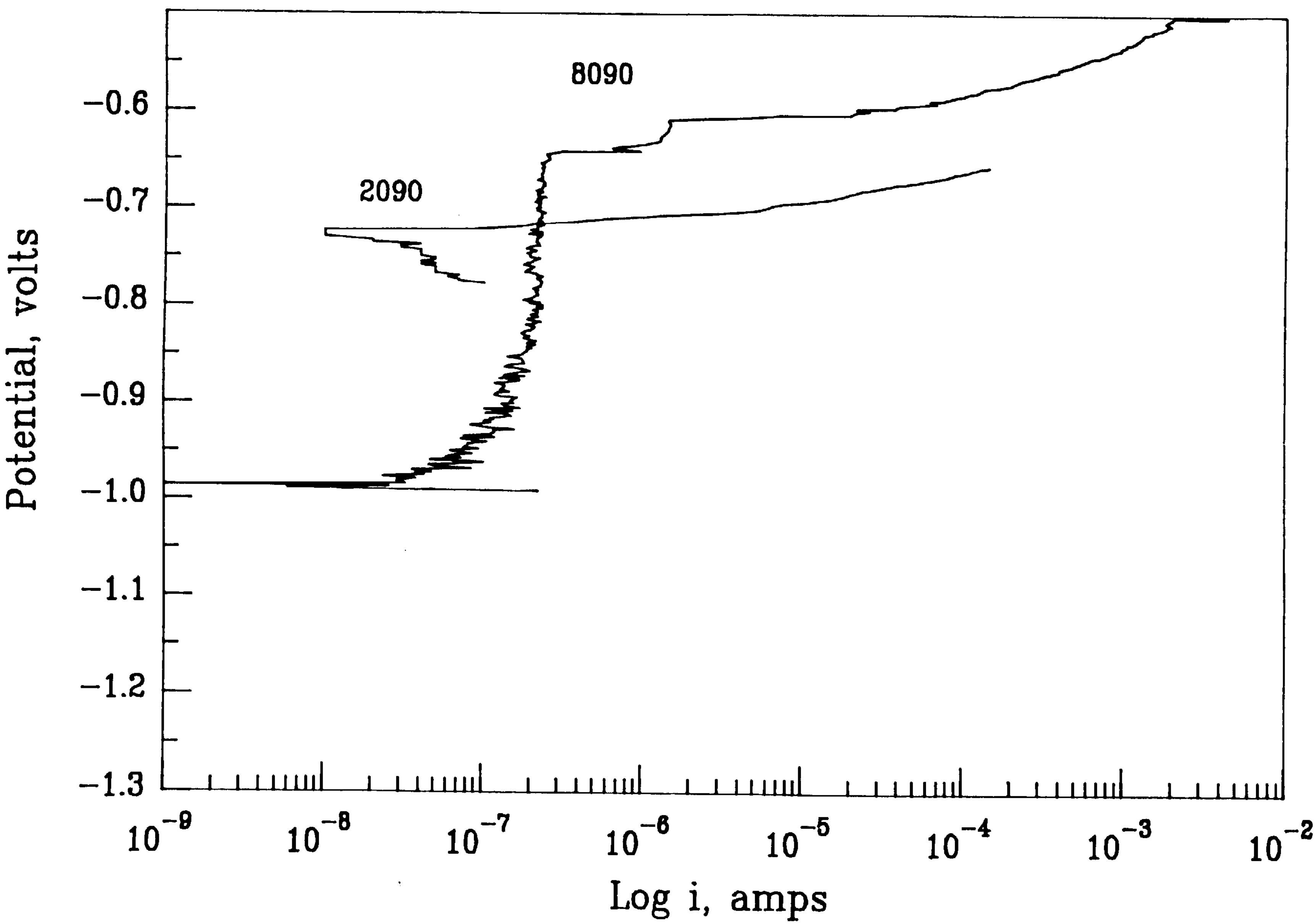
8090 + 0.5 w/o Zn (654705)

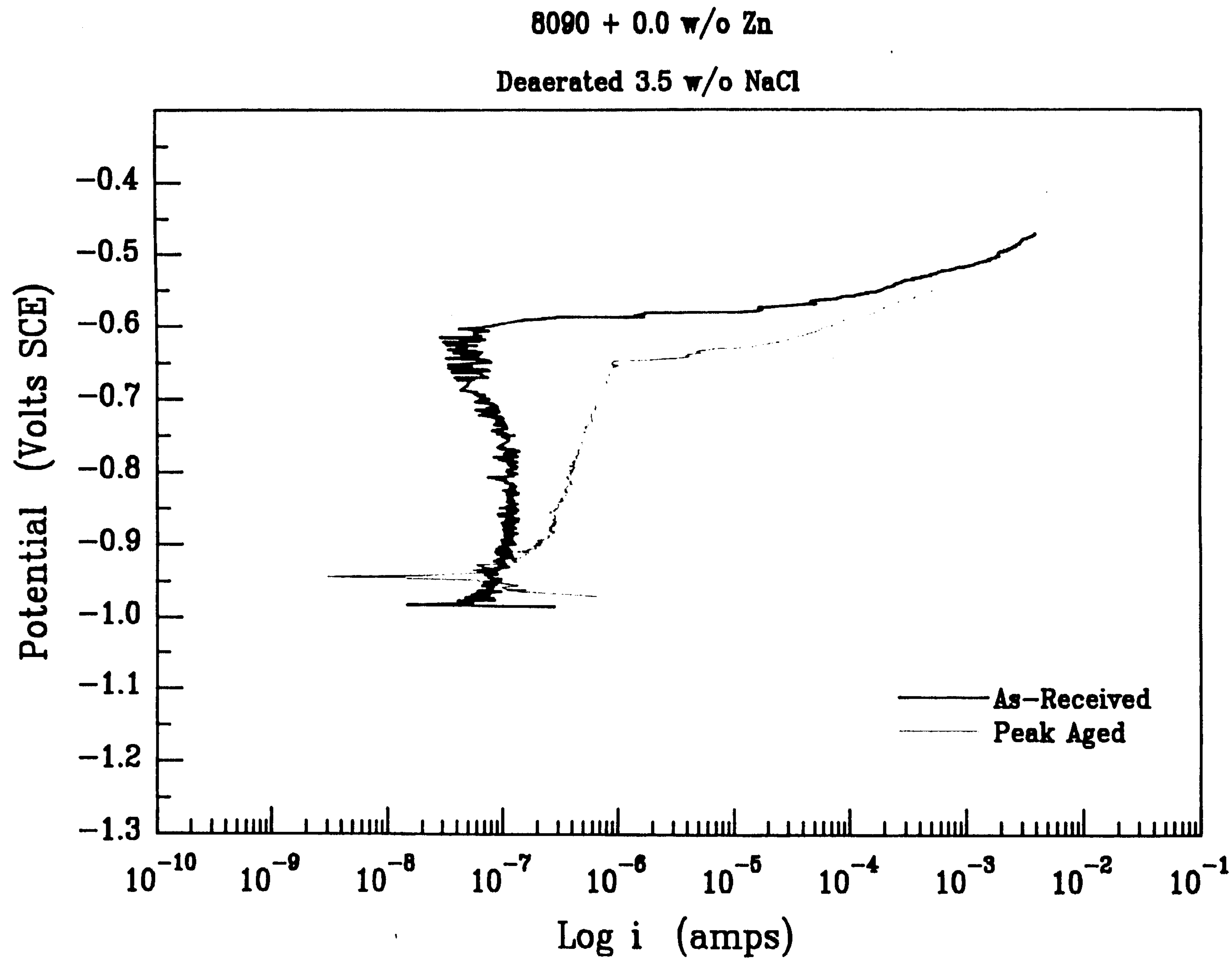
8090 + 1.0 w/o Zn (654706)



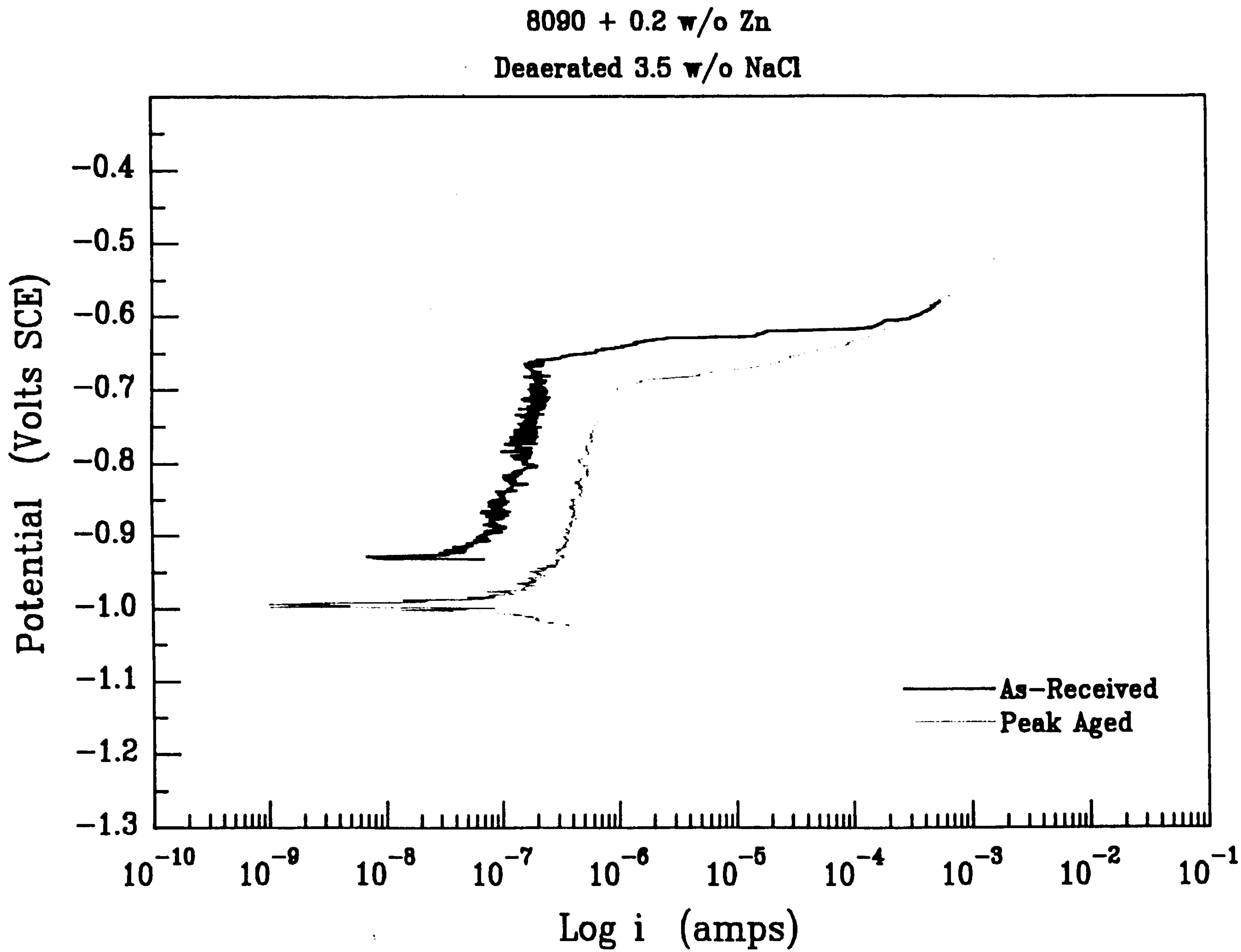
8090 + 1.0 w/o Zn (654706)

Deaerated 3.5 w/o NaCl

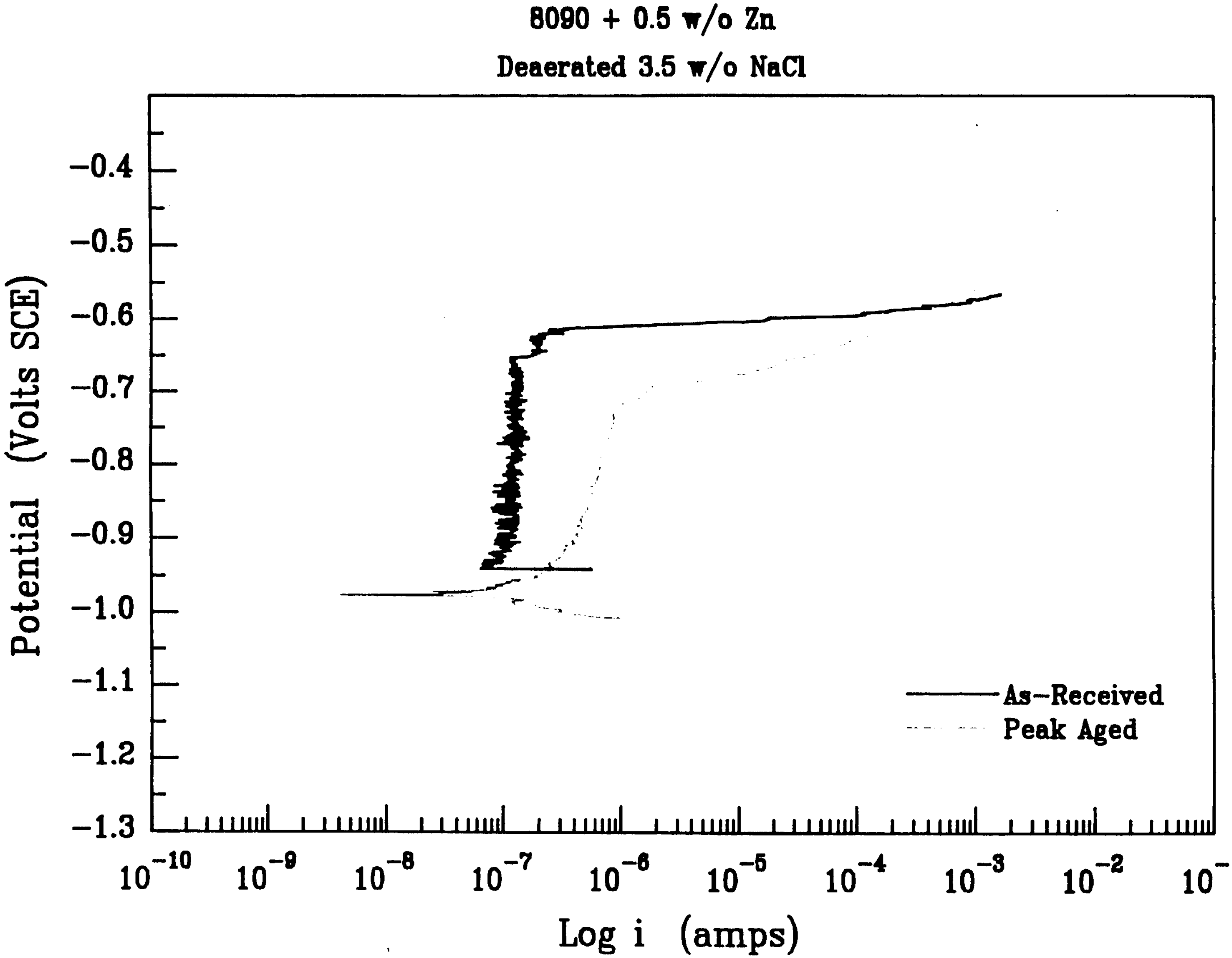




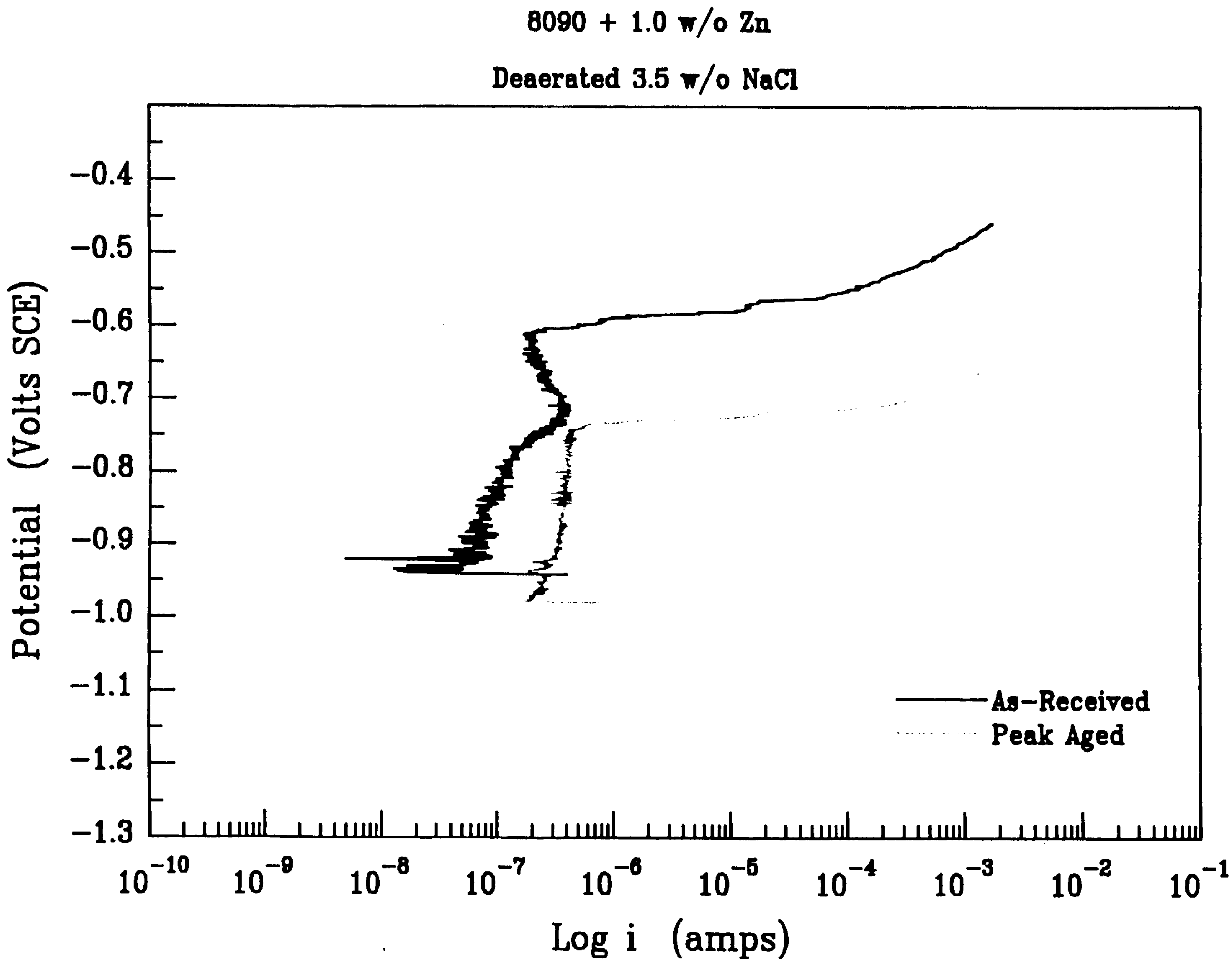
8090 + 0.0 w/o Zn
Deaerated 3.5 w/o NaCl
Potential (Volts SCE)
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.1
-1.2
-1.3
10^{-10}
10^{-9}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Log i (amps)
As-Received
Peak Aged



8090 + 0.2 w/o Zn
Deaerated 3.5 w/o NaCl
Potential (Volts SCE)
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9
−1.0
−1.1
−1.2
−1.3
10^−10
10^−9
10^−8
10^−7
10^−6
10^−5
10^−4
10^−3
10^−2
10^−1
Log i (amps)
As−Received
Peak Aged



8090 + 0.5 w/o Zn
Deaerated 3.5 w/o NaCl
Potential (Volts SCE)
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.1
-1.2
-1.3
10^{-10} 10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1}
Log i (amps)
As-Received
Peak Aged


8090 + 1.0 w/o Zn
Deaerated 3.5 w/o NaCl
Potential (Volts SCE)
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.1
-1.2
-1.3
10^{-10}
10^{-9}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Log i (amps)
As-Received
Peak Aged